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IEEE TRANSACTIONS ON COMMUNICATIONS, vol. COM-32, no. 1, January 1984, pages 81-87, IEEE, New York, US; J.P. McGEEHAN et al.: "Phase-locked transparent tone-in-band (TTIB): a new spectrum configuration particularly suited to the transmission of data over SSB mobile radio networks"

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Description

The present invention relates to apparatus and methods for demodulating signals, particularly data signals, transmitted using a transparent tone-in band (TTIB) system. British Patent Application No. 2161661A introduces TTIB systems and various embodiments are described. An introduction to TTIB and various embodiments are also described in the paper "Phase-Locked Transparent Tone-in-Band (TTIB): A New Spectrum Configuration Particularly Suited to the Transmission of Data Over SSB Mobile Radio Networks" by J.P. McGeehan and A.J. Bateman, IEEE Transactions on Communications, COM-32 (1984) Jan., No. 1, New York.

Where data signals are to be transmitted the data signals are used to modulate a carrier signal before the "notch" in the frequency spectrum is generated. The carrier signal may then be positioned in the notch during transmission and retrieved at the receiver to allow demodulation after the original spectrum (without the notch) has been restored.

According to a first aspect of the present invention there is provided a receiver for a communication system which employs a transmitter and the receiver, the transmitter comprising

modulation means for modulating a carrier signal with an information signal,

frequency selection and translation means for dividing a frequency band containing the modulated signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means for transmitting the upper and lower portions and the said carrier signal, with the carrier signal translated in frequency,

the receiver comprising

comparison means for comparing the frequency and phase of signals from the lower and upper portions, on reception, before frequency translation to the original spectrum of the information signal,

characterised in that the receiver also comprises

generating means for generating a demodulation signal, the generating means being coupled to receive the output signal of the comparison means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means for demodulating at least one of the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in that portion or portions occupied in the said information signal before modulation and di-

vision.

According to a second aspect of the invention there is provided a receiver for a communication system which employs a transmitter and the receiver, the transmitter comprising

modulation means for modulating a carrier signal with an information signal,

frequency selection and translation means for dividing a frequency band containing the modulated signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means for transmitting the upper and lower portions and the said carrier signal, with the carrier signal translated in frequency,

the receiver comprising

correcting means for comparing the frequency and phase of signals from the lower and upper portions, on reception, following frequency translation to the original spectrum of the information signal,

characterised in that the receiver comprises

generating means for generating a demodulation signal, the generating means being coupled to receive the output signal from the correcting means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means for demodulating the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

In the transmitter, the modulation means may comprise a mixer receiving the information signal and the carrier signal but as an alternative the modulation means may comprise a modem employing, for example, binary phase-shift keying (BPSK) or quadrature phase-shift keying (QPSK).

Where the upper and lower portions correspond to the upper and lower sidebands of the output signal of the modulation means and a suitable simple modulation technique is used, for example BPSK, then it may sometimes only be necessary to demodulate only the upper or lower portion at the receiver, since each sideband theoretically contains all the information in the information signal. However since the processes used for forming the upper and lower portions are not perfect, some of the information will usually be lost unless both portions are demodulated. Preferably therefore the demodulation means is constructed to demodulate the upper and lower portions using the said demodulation signal and another demodulation signal, respectively. These signals are hereinafter

referred to as the first and second demodulation signals.

The main advantage of the present invention is the direct demodulation of at least one of the upper and lower portions without previously restoring the spectrum to its original condition in the receiver.

Preferably the carrier signal is inserted, after frequency changing if required, into the notch in the transmitter and the generating means extracts the carrier signal from the signal received.

The correcting means may be coupled to receive, as input signals, at least parts of the upper and lower portions. Alternatively the correcting means may be coupled to receive, as input signals, demodulated output signals from the demodulation means, these output signals being dependent on any difference in frequency and phase in the upper and lower portions. Thus the correction applied in deriving the first and second demodulation signals may be "feed forward" or "feedback".

Where the feed forward alternative is employed, the upper and lower portions must contain at least one signal present at a significant level in both portions and the correcting means may include first mixer means coupled to receive at least parts of the first and second portions containing the said one signal and deriving as its output signal a signal having a frequency which is equal to the notch width. This output signal may then be coupled to means for dividing frequency by two to provide the output signal of the correcting means. The generating means may then employ a second mixer means which receives the carrier signal and the output signal from the correcting means and provides two output signals corresponding to upper and lower sidebands which are then used as the first and second demodulation signals and applied to third and fourth mixer means which demodulate the upper and lower portions, respectively.

Where the feedback alternative is used, the correcting means may comprise first mixer means which controls a locally generated reference signal and the generating means may comprise a second mixer which receives the carrier signal and the locally generated reference signal, and generates the first and second demodulating signals as upper and lower sidebands. The demodulation means may comprise third and fourth mixer means and the first mixer means may be coupled to receive the output signals of the third and fourth mixer means as input signals.

According to a third aspect of the present invention there is provided a receiver method for processing signals received in a communication system which employs transmission and receiver methods, the transmission method comprising modulating a carrier signal with an information signal, dividing the frequency spectrum containing the

modulated signal into lower and upper portions with a frequency notch between the lower and upper portions, and transmitting the upper and lower portions and the carrier signal, with the carrier signal translated in frequency, and

the receiver method comprising

comparing the frequency and phase of signals from the lower and upper portions, on reception, before frequency translation to the original spectrum of the information signal, to provide a comparison output signal,

characterised in that the receiver method also comprises

generating first and second demodulation signals and employing the comparison output signal and the frequency translated carrier signal in generating the first and second demodulation signals, and

demodulating the upper and lower portions using the first and second demodulation signals respectively to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

According to a fourth aspect of the present invention there is provided a receiver method for processing signals received in a communication system which employs transmission and receiver methods, the transmission method comprising modulating a carrier signal with an information signal, dividing the frequency spectrum containing the modulated signal into lower and upper portions with a frequency notch between the lower and upper portions, and transmitting the upper and lower portions and the carrier signal, with the carrier signal translated in frequency, and

the receiver method comprising

deriving a correcting signal by comparing the frequency and phase of signals from the lower and upper portions, on reception, following frequency translation to the original spectrum of the information signal,

generating first and second demodulation signals and employing the correcting signal and the frequency translated carrier signal in generating the first and second demodulation signals, and

demodulating the upper and lower portions using the first and second demodulation signals respectively to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

The above mentioned means and methods steps may be implemented by operations, or groups of operations, programmed into an integrated circuit containing a microprocessor. For example a digital signal processor integrated circuit can be programmed in this way to form the various demodulators, mixer means and filters required.

Certain embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a TTIB transmitter used in an embodiment of the invention,

Figure 2a shows the frequency spectrum at the output of Figure 1,

Figure 2b shows a frequency spectrum used in explaining the operation of Figure 3,

Figure 3 is a block diagram of a receiver according to the invention employing feed forward control,

Figure 4 is a block diagram of a receiver according to the invention employing feedback control,

Figure 5 is a block diagram of a digital signal processor circuit which may be used to replace the transmitter of Figure 1 or the receiver of Figure 3 or 4,

Figures 6 and 7 are flow charts for transmitter and receiver programs, respectively, and

Figure 8 is a block diagram of another TTIB transmitter used in an alternative embodiment of the invention.

In Figure 1 binary data is applied to a mixer 10 which also receives a carrier signal f_c from an oscillator 11. The binary data is usually received as rectangular pulses but it is shaped by passage through a low-pass filter (not shown) before reaching the mixer 10. Both sidebands from the mixer 10 covering, for example, a frequency spectrum from 600 Hz to 3.6 kHz pass through a low pass filter 12 before reaching a low pass filter 13 and a mixer 14. A lower portion of the spectrum, for example from 600 Hz to 1.8 kHz is selected by the filter 13 and applied to a combining circuit 15. The mixer 14 also receives a reference signal at a frequency f_1 and the lower portion of the lower sideband of the output signal from the mixer 14 is selected using a low pass filter 16. The output from the filter 16 corresponds to the upper portion of the band from the mixer 10 which is not passed by the filter 13 (in the example this output corresponds to that part of the original band extending from 1.8 Hz to 3.6 Hz). A further step in frequency translation now takes place in a mixer 17 which receives a reference signal f_2 which results in an output signal with two sidebands each corresponding to the upper portion of the spectrum from the mixer 10. This upper portion is combined with the lower portion in the summing circuit 15 and the upper sideband of the output from the mixer 17 is removed by a low pass filter 18. The resultant spectrum at the output from the filter 18 is shown in Figure 2 and includes a lower portion 19, an upper portion 21 and a frequency "notch" 22 whose width is equal to $f_2 - f_1$. In the present example the notch is 600 Hz wide and therefore the upper portion 21 extends from

2.4 kHz to 4.2 kHz.

The carrier signal for the mixer 10 is also applied to a mixer 23 which receives a reference signal f_3 and the upper sideband of the signal from the mixer 23 is placed in the notch by choice of the frequency f_3 . Preferably the upper sideband is placed at the centre of the notch by making f_3 equal to $(f_2 - f_1)/2$. The frequency f_c and the lower sideband are removed by a high pass filter 24 before application to the combining circuit 15. The signal in the notch is designated 25 in Figure 2. The process of generating a frequency notch as described above is similar to that described in British Specification 2161661 mentioned above.

The output signal from the circuit of Figure 1 can now be applied to a single sideband (SSB) radio link with a pilot tone for the SSB system also inserted into the notch. Alternatively another radio or line link may be employed.

Before considering the receiver an alternative transmitter shown in Figure 8 is described. Incoming data passes to a data shaping filter 75 (not shown in Figure 1) and then to a mixer 76 which receives the carrier frequency f_c . Both sidebands are passed to a low-pass filter 77 and a high-pass filter 78 (which may be mirror filters) so that the lower sideband appears at the output of the filter 77 and the upper sideband appears at the output of the filter 78. A frequency downconverter 79 receives the lower sideband and two reference signals of frequency f_0 in phase quadrature with one another from an oscillator 81 and a 90° phase shift circuit 82. The downconverter 79 comprises an "in phase" mixer 83 and a "quadrature" mixer 84, the latter receiving the lower sideband by way of a 90° phase shift circuit 85. When the outputs of the mixers 83 and 84 are summed in a summing circuit the resulting new lower sidebands add and the new upper sidebands cancel. A frequency up-converter 86 operates in a similar way on the upper sideband signal from the filter 78 except, as indicated by the plus and minus signs adjacent to a summing circuit 87, the quadrature input is subtracted from the in phase input so that the upper sidebands add and the lower sidebands cancel. The outputs from the downconverter 79, the up-converter 86 and the oscillator 11 are added by a summing circuit 88 to give a signal similar to that shown in Figure 2a except that the notch width is now $2f_0$ and the signal 25 is at the carrier frequency f_c .

After transmission to remote location the conventional process of SSB demodulation or other demodulation takes place at the receiver and then the resulting spectrum which is nominally as shown in Figure 2b is applied to a circuit shown in Figure 3. The lower and upper portions, below and above the notch respectively, are separated by means of

low and high pass filters 30 and 31 respectively and applied to mixers 32 and 33 (which may be mirror filters) where demodulation takes place. The outputs from the mixers 32 and 33 are combined in a combining circuit 34 whose output forms the data signal and passes by way of a low pass filter 35.

In order to obtain correct reference signals for demodulation in the mixers 32 and 33, the signal 25 in the notch requires frequency translation and phase correction to appropriate positions in the received spectrum. Assuming the original modulated carrier f_c was at the centre of the band where the frequency notch was introduced it must be restored to the position 37 shown in Figure 2(b) and equally the demodulating signal for the upper portion must be positioned at the lower end of this portion as shown at 38 in Figure 2(b). The signal 25 in the notch of the received spectrum is selected by a band pass filter 36 and applied to a mixer 40 which nominally shifts the frequency of the signal 25 up and down by the frequency f_3 . The two resulting signals form the upper and lower sidebands of the output of the mixer 40 and are applied by way of a low pass filter 42 to the mixer 33 and by way of a high pass filter 43 to the mixer 32.

The required corrected value of f_3 is obtained as follows. For this embodiment of the invention to function the sides of the notch must not be perfect as shown but have a finite roll-off imparted by the filters 13 and 16 of Figure 1. The upper and lower portions are applied to a mixer 44 and since signals in the two portions which correspond in that they originate from the same frequency in the spectrum before the notch was inserted (and are present by virtue of the above mentioned roll-off portions) are separated by the notch width, the lower sideband of the output of the mixer 44 is a signal whose frequency is equal to the notch width; that is $f_2 - f_1$ which equals $2f_3$ when the carrier signal is at the centre of the notch. This frequency is halved in a frequency divider 45 and applied as the reference signal to the mixer 40 so that any distortion in the notch due for example to frequency drift in the transmitter oscillators is automatically compensated.

A block diagram of an alternative circuit to Figure 3 which uses feedback control is shown in Figure 4. Filters 30, 31, 35 and 36, mixers 32 and 33 and the combining circuit 34 perform the same functions as in Figure 4. However the control signals for correcting the demodulation signals applied to the mixers 32 and 33 are derived from signals at the output of these mixers, the output of the mixer 33 being applied directly to a mixer 50 and that from the mixer 32 being applied by way of a quadrature phase-shift circuit 51 to the mixer 50. The output of the mixer 50 is a magnitude signal

which is used to vary the frequency and phase of an oscillator 52 which is nominally at f_3 . As for Figure 3 the mixers 32 and 33 require reference signals positioned as shown at 37 and 38 in Figure 2(b) and these signals are obtained as lower and upper sidebands of the output from a mixer 53, the appropriate sidebands being selected by a low pass filter 54 and a high pass filter 55, respectively. The outputs of the mixers 32 and 33 in Figure 4 (and Figure 3) should theoretically be identical since the upper and lower portions correspond to the upper and lower sidebands of the modulator 10, and each sideband contains all the information of the data input. The signals applied to the circuit 51 from the mixer 32 and to the mixer 50 from the mixer 33 are therefore nominally identical and any difference is derived by the mixer 50 and used to correct the frequency of the oscillator 52. The circuits 32, 33 and 50 to 54 can be regarded as forming a phase locked loop, and the phase-shift circuit 51 ensures that the error correction signal is zero when frequency and phase are correct.

Some of the data information will almost certainly be absent from the output of at least one of the demodulators 32 and 33 due to the roll-off of the various filters, and it is preferable to combine both outputs as shown using the combining circuit 35, although there may be some circumstances when the output of one demodulator only is sufficient.

The mixer 10 and 76 of Figures 1 and 8 may be replaced by a modem employing BPSK or QPSK, the carrier signal then being generated within the modem. If a more complicated modulation system than BPSK is used, for example QPSK, then it is necessary to demodulate both upper and lower sidebands and use a combining circuit to derive the data output. Where more complicated modulation takes place in the transmitter, the demodulation in the receiver must, of course, correspond. At least one demodulation signal of appropriate frequency and phase is derived and correction of frequency and phase, which is dependent on a signal present in the upper and lower portions is required for a low error data output.

The circuits shown above can be put into operation using discrete filters and mixers, either analogue or digital and other discrete component circuits or they can be wholly or partially formed by programming the digital signal processor integrated circuits mentioned above or similar processors. It is well known that digital filters are implemented by successive multiplication and addition operations and the processors mentioned are specially adapted to carry out such multiplications at high speed. The various mixers shown are also ideal for implementation as multiplication processes in a programmed signal processor.

An example of a microprocessor circuit which can be used to replace the transmitter of Figure 1 or the receiver of Figures 3 or 4 is shown in Figure 5. Analogue signals are applied to a terminal 60 and then pass by way of an amplifier 61 and an antialiasing filter 62 to an analogue-to-digital converter (A/D) 63. A digital signal processor (DSP) 64 (that is a specialised microprocessor) such as the Texas TMS 320-10 or 320-20 receives the output from the A/D 63 and provides output digital samples to a digital-to-analogue converter (D/A) 65. A read-only memory 66 contains the program for the DSP and a random-access memory 67 for use during the operation of the program is also connected to the DSP. Analogue signals from the D/A 65 pass through an antialiasing filter 68 and an amplifier 69 to an output terminal 70.

An example of a program for the DSP 64 when used to replace the transmitter of Figure 1 is given in the form of the flow chart of Figure 6. Since this flow chart is analogous to Figure 1 it will not be described except to point out that the various low pass filtering subroutines may or may not be the same but where they are the same their frequency characteristics depend on the parameters supplied to the subroutine so that the required different characteristics are obtained. The flow chart of Figure 7 is an example of a program for the use of the DSP 64 as the receiver of Figure 3.

Although some ways of putting the invention into effect have been specifically described it will be clear that there are many ways of doing so. For example the notch may be so positioned that no frequency translation of the carrier signal f_c is required in the transmitter. Also the above mentioned British Patent Application and the corresponding United States Application No. 617733 show other methods of providing and employing TTIB as do British Patent Applications Nos. 8520580, 8519545 and 8430319, and many of these methods may be used with the present invention, in particular shifting both upper and lower portions of the spectrum in forming the notch.

Two forms of receiver locking system have been specifically described but others may be used, for example receivers in which the reference signal for one of the demodulators 32 and 33 only is corrected.

Claims

1. A receiver for a communication system which employs a transmitter and the receiver, the transmitter comprising
 - modulation means (10, 11, 75, 76) for modulating a carrier signal with an information signal,
 - frequency selection and translation means

(12 to 17, 23, 24, 77, 78, 79, 86) for dividing a frequency band containing the modulated signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means (15, 18, 88) for transmitting the upper and lower portions and the said carrier signal, with the carrier signal translated in frequency,

the receiver comprising

comparison means (44, 45) for comparing the frequency and phase of signals from the lower and upper portions, on reception, before frequency translation to the original spectrum of the information signal,

characterised in that the receiver also comprises

generating means (40, 42, 43) for generating a demodulation signal, the generating means being coupled to receive the output signal of the comparison means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means (32, 33) for demodulating at least one of the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in that portion or portions occupied in the said information signal before modulation and division.

2. A communication system including a transmitter and a receiver,

the transmitter comprising modulator means (10, 11, 75, 76) for modulating a carrier signal with an information signal,

frequency selection and filtering means (12 to 17, 23, 24, 77, 78, 79, 86) for dividing the frequency spectrum containing the modulated carrier signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means (15, 18, 88) for transmitting the upper and lower portions and the carrier signal, with the carrier signal translated in frequency,

the receiver comprising

means (44, 45) for comparing the frequency and phase of signals from the lower and upper portions, on reception, before frequency translation to the original spectrum of the information signal,

characterised in that the receiver comprises

generating means (40, 42, 43) for generating a demodulation signal, the generating means being coupled to receive the output signal of the comparison means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means (32, 33) for demodulating at least one of the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in that portion or portions occupied in the said information signal before modulation and division.

3. A receiver for a communication system which employs a transmitter and the receiver, the transmitter comprising

modulation means (10, 11, 75, 76) for modulating a carrier signal with an information signal,

frequency selection and translation means (12 to 17, 23, 24, 77, 78, 79, 86) for dividing a frequency band containing the modulated signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means (15, 18, 88) for transmitting the upper and lower portions and the said carrier signal, with the carrier signal translated in frequency,

the receiver comprising
correcting means (50, 51) for comparing the frequency and phase of signals from the lower and upper portions, on reception, following frequency translation to the original spectrum of the information signal,

characterised in that the receiver comprises

generating means (52 to 55) for generating a demodulation signal, the generating means being coupled to receive the output signal from the correcting means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means (32, 33) for demodulating the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

4. A communication system including a transmitter and a receiver,

the transmitter comprising modulator means (10, 11, 75, 76) for modulating a carrier signal with an information signal,

frequency selection and filtering means (12 to 17, 23, 24, 71, 78, 79, 86) for dividing the frequency spectrum containing the modulated carrier signal into upper and lower portions and for carrying out frequency translation, the output signal of the frequency selection and translation means having at least one said portion which is translated in frequency to provide a notch between the lower and upper portions, and

means (15, 18, 88) for transmitting the upper and lower portions and the said carrier signal, with the carrier signal translated in frequency,

the receiver comprising
correcting means (50, 51) for comparing the frequency and phase of signals from the lower and upper portions, on reception, following frequency translation to the original spectrum of the information signal,

characterised in that the receiver comprises

generating means (52 to 55) for generating a demodulation signal, the generating means being coupled to receive the output signal from the correcting means and the frequency translated carrier signal and employ them in generating the demodulation signal, and

means (32, 33) for demodulating the upper and lower portions using the demodulation signal to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

5. A communication system according to Claim 2 or 4 characterised in that the transmitter modulation means comprises means (10, 11, 76) for mixing the information signal and the carrier signal.

6. A communication system according to Claim 2 or 4 characterised in that the transmitter modulation means comprises a modem employing one of the following techniques: binary phase-shift keying and quadrature phase-shift keying.

7. A receiver according to Claim 1 characterised in that in addition to the said demodulation signal, that is a first demodulation signal, the generating means is arranged to generate a second demodulation signal using the output signal of the comparison means, and the means for demodulating is arranged to demodulate the upper and lower portions using

the said first and second demodulation signals, respectively.

8. A receiver according to Claim 3 characterised in that in addition to the said demodulation signal, that is a first demodulation signal, the generating means is arranged to generate a second demodulation signal using the said correcting signal, and the means for demodulating is arranged to demodulate the upper and lower portions using the said first and second demodulation signals, respectively. 5 10
9. A receiver according to Claim 1, 3, 7 or 8 for a communication system characterised in that the transmitter includes means (15, 88) for inserting the carrier signal into the notch, the receiver including means (36) for extracting the carrier signal from the notch, on reception. 15 20
10. A receiver according to Claim 1 or 7 characterised in that the comparison means comprises first receiver mixer means (44) arranged to receive the said input signals and to derive a notch width signal having a frequency equal to the notch width, and means (45) for deriving the comparison means output signal from the notch width signal. 25
11. A receiver according to Claim 10 insofar as dependent on Claims 7 and 9 characterised in that the generating means comprises a second receiver mixer means (40) arranged for receiving and mixing the carrier signal and the output signal of the comparison means and for generating the first and second demodulation signals as upper and lower sidebands resulting from the said mixing, and the receiver also includes third and fourth mixer means (32, 33) arranged to receive the first and second demodulation signals, and to demodulate the upper and lower portions, respectively. 30 35 40
12. A receiver according to Claim 1, 8 or 9 characterised in that the correcting means (50, 51) is arranged to receive, as input signals, demodulated output signals from the demodulation means. 45
13. A receiver according to Claim 12 insofar as dependent on Claims 8 and 9 characterised in that the correcting means comprises first receiver mixer means (50) for deriving the correcting signal, and the generating means comprises a local generator (52) for generating a reference signal having a frequency controlled by the correcting signal, and second receiver mixer means (53) arranged to receive the car- 50 55

rier signal and the said reference signal and to generate the first and second demodulation signals.

14. A receiver according to Claim 13 characterised in that the demodulation means comprises third and fourth receiver mixer means (32, 33) and the first receiver mixer means (50) is arranged to receive the output signals of the third and fourth receiver mixer means as input signals.
15. A receiver according to any of Claims 1 or 8 to 14 characterised in that at least some of the said means are formed by a programmed computer (64).
16. A communication system according to Claim 2, 4, 5 or 6 characterised in that at least some of the said means of the transmitter and/or the receiver are formed by a programmed computer (64).
17. A receiver method for processing signals received in a communication system which employs transmission and receiver methods, the transmission method comprising modulating a carrier signal with an information signal, dividing the frequency spectrum containing the modulated signal into lower and upper portions with a frequency notch between the lower and upper portions, and transmitting the upper and lower portions, and the carrier signal, with the carrier signal translated in frequency, and the receiver method comprising
 - comparing the frequency and phase of signals from the lower and upper portions, on reception, before frequency translation to the original spectrum of the information signal, to provide a comparison output signal,
 - characterised in that the receiver method also comprises
 - generating first and second demodulation signals and employing the comparison output signal and the frequency translated carrier signal in generating the first and second demodulation signals, and
 - demodulating the upper and lower portions using the first and second demodulation signals respectively to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.
18. A receiver method for processing signals received in a communication system which employs transmission and receiver methods, the transmission method comprising modulating a

carrier signal with an information signal, dividing the frequency spectrum containing the modulated signal into lower and upper portions with a frequency notch between the lower and upper portions, and transmitting the upper and lower portions and the carrier signal, with the carrier signal translated in frequency, and

the receiver method comprising

deriving a correcting signal by comparing the frequency and phase of signals from the lower and upper portions, on reception, following frequency translation to the original spectrum of the information signal,

generating first and second demodulation signals and employing the correcting signal and the frequency translated carrier signal in generating the first and second demodulation signals, and

demodulating the upper and lower portions using the first and second demodulation signals respectively to occupy the same frequency range as signals in those portions occupied in the said information signal before modulation and division.

Patentansprüche

1. Empfänger für ein Kommunikationssystem, welches einen Sender und den Empfänger verwendet, wobei der Sender umfaßt: Modulatoren (10,11,75,76) zur Modulation eines Trägersignals mit einem Informationssignal, Frequenzauswahl- und -umsetzeinrichtung (12 bis 17, 23,24,77,78,79,86) zur Teilung eines das modulierte Signal enthaltende Frequenzbands in obere und untere Bereiche und zur Durchführung der Frequenzumsetzung, wobei das Ausgangssignal der Frequenzauswahl- und -umsetzeinrichtung zumindest einen Bereich umfaßt, der so frequenzumgesetzt ist, daß ein Frequenzloch zwischen den unteren und den oberen Bereichen entsteht, und eine Einrichtung (15,18,88) zur Übertragung der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals, wobei der Empfänger umfaßt: eine Vergleichseinrichtung (44,45) zum Vergleich der Frequenz und der Phase der Signale der unteren und der oberen Bereiche bei Empfang und vor der Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals, dadurch gekennzeichnet, daß der Empfänger weiterhin umfaßt: Generierungseinrichtungen (40,42,43) zum Erzeugen eines Demodulationssignals, wobei die Generierungseinrichtungen gekoppelt sind, um das Ausgangssignal der Vergleichseinrichtung und das frequenzumgesetzte Trägersignal zu empfangen und diese beim Erzeugen des Demodulationssignals einzusetzen, und eine Einrichtung (32,33) zur Demodulation von zumindest einem der oberen und der unteren Bereiche, wobei das Demodulationssignal verwendet wird, um denselben Frequenzabschnitt zu belegen, wie die Signale in dem Bereich oder den Bereichen, die in dem Informationssignal vor der Modulation und der Teilung belegt sind.

pelt sind, um das Ausgangssignal der Vergleichseinrichtung und das frequenzumgesetzte Trägersignal zu empfangen und diese beim Erzeugen des Demodulationssignals einzusetzen, und

eine Einrichtung (32,33) zur Demodulation von zumindest einem der oberen und der unteren Bereiche, wobei das Demodulationssignal verwendet wird, um denselben Frequenzabschnitt zu belegen, wie die Signale in dem Bereich oder den Bereichen, die in dem Informationssignal vor der Modulation und der Teilung belegt sind.

2. Kommunikationssystem mit einem Sender und einem Empfänger, wobei der Sender umfaßt: Modulatoren (10,11,75,76) zur Modulation eines Trägersignals mit einem Informationssignal, eine Frequenzauswahl- und -umsetzeinrichtung (12 bis 17, 23,24,77,78,79,86) zur Teilung eines das modulierte Signal enthaltende Frequenzbands in obere und untere Bereiche und zur Durchführung der Frequenzumsetzung, wobei das Ausgangssignal der Frequenzauswahl- und -umsetzeinrichtung zumindest einen Bereich umfaßt, der so frequenzumgesetzt ist, daß ein Frequenzloch zwischen den unteren und den oberen Bereichen entsteht, und eine Einrichtung (15,18,88) zur Übertragung der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals, wobei der Empfänger umfaßt: eine Vergleichseinrichtung (44,45) zum Vergleich der Frequenz und der Phase der Signale der unteren und der oberen Bereiche bei Empfang und vor der Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals, dadurch gekennzeichnet, daß der Empfänger weiterhin umfaßt: Generierungseinrichtungen (40,42,43) zum Erzeugen eines Demodulationssignals, wobei die Generierungseinrichtungen gekoppelt sind, um das Ausgangssignal der Vergleichseinrichtung und das frequenzumgesetzte Trägersignal zu empfangen und diese beim Erzeugen des Demodulationssignals einzusetzen, und eine Einrichtung (32,33) zur Demodulation von zumindest einem der oberen und der unteren Bereiche, wobei das Demodulationssignal verwendet wird, um denselben Frequenzabschnitt zu belegen, wie die Signale in dem Bereich oder den Bereichen, die in dem Informationssignal vor der Modulation und der Teilung belegt sind.

3. Empfänger für ein Kommunikationssystem, welches einen Sender und den Empfänger verwendet, wobei der Sender umfaßt:

Modulatoren (10,11,75,76) zur Modulation eines Trägersignals mit einem Informationssignal,

eine Frequenzauswahl- und -umsetzeinrichtung (12 bis 17, 23,24,77,78,79,86) zur Teilung eines das modulierte Signal enthaltende Frequenzbands in obere und untere Bereiche und zur Durchführung der Frequenzumsetzung, wobei das Ausgangssignal der Frequenzauswahl- und -umsetzeinrichtung zumindest einen Bereich umfaßt, der so frequenzumgesetzt ist, daß ein Frequenzloch zwischen den unteren und den oberen Bereichen entsteht, und eine Einrichtung (15,18,88) zur Übertragung der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals,

wobei der Empfänger umfaßt:

eine Korrekturereinrichtung (50,51) zum Vergleich der Frequenz und der Phase der Signale der unteren und der oberen Bereiche bei Empfang, gefolgt von einer Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals,

dadurch gekennzeichnet,

daß der Empfänger umfaßt:

Generierungseinrichtungen (52-55) zum Erzeugen eines Demodulationssignals, wobei die Generierungseinrichtungen gekoppelt sind, um das Ausgangssignal der Vergleichseinrichtung und das frequenzumgesetzte Trägersignal zu empfangen und diese beim Erzeugen des Demodulationssignals einzusetzen, und eine Einrichtung (32,33) zur Demodulation der oberen und der unteren Bereiche, die das Demodulationssignal verwenden, um denselben Frequenzabschnitt zu besetzen, wie die Signale in jenen Bereichen, die in dem Informationssignal vor der Modulation und der Teilung besetzt sind.

4. Kommunikationssystem mit einem Sender und einem Empfänger, wobei der Sender umfaßt:

Modulatoren (10,11,75,76) zur Modulation eines Trägersignals mit einem Informationssignal,

eine Frequenzauswahl- und -umsetzeinrichtung (12 bis 17, 23,24,77,78,79,86) zur Teilung eines das modulierte Signal enthaltende Frequenzbands in obere und untere Bereiche und zur Durchführung der Frequenzumsetzung, wobei das Ausgangssignal der Frequenzauswahl- und -umsetzeinrichtung zumindest einen Bereich umfaßt, der so frequenzumgesetzt ist, daß ein Frequenzloch zwischen den unteren und den

oberen Bereichen entsteht, und

eine Einrichtung (15,18,88) zur Übertragung der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals,

wobei der Empfänger umfaßt:

eine Korrekturereinrichtung (50,51) zum Vergleich der Frequenz und der Phase der Signale der unteren und der oberen Bereiche bei Empfang, gefolgt von einer Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals,

dadurch gekennzeichnet,

daß der Empfänger umfaßt:

Generierungseinrichtungen (52-55) zum Erzeugen eines Demodulationssignals, wobei die Generierungseinrichtungen gekoppelt sind, um das Ausgangssignal der Korrekturereinrichtung und das frequenzumgesetzte Trägersignal zu empfangen und diese beim Erzeugen des Demodulationssignals einzusetzen, und

eine Einrichtung (32,33) zur Demodulation der oberen und der unteren Bereiche, wobei das Demodulationssignal verwendet wird, um denselben Frequenzabschnitt zu besetzen, wie die Signale in jenen Bereichen, die in dem Informationssignal vor der Modulation und der Teilung besetzt sind.

5. Kommunikationssystem nach Anspruch 2 oder 4, dadurch gekennzeichnet, daß die Sender-Modulationseinrichtung eine Einrichtung (10,11,76) umfaßt, die das Informationssignal und das Trägersignal mischt.

6. Kommunikationssystem nach Anspruch 2 oder 4, dadurch gekennzeichnet, daß die Sender-Modulationseinrichtung ein Modem umfaßt, welches eine der folgenden Techniken einsetzt:
binäre Phasenschiebe-Umtastung und Quadratur-Phasenschiebe-Umtastung.

7. Empfänger nach Anspruch 1, dadurch gekennzeichnet, daß die Generierungseinrichtungen so ausgebildet sind, daß zusätzlich zu dem Demodulationssignal, welches ein erstes Demodulationssignal ist, ein zweites Demodulationssignal generiert wird, indem das Ausgangssignal der Vergleichseinrichtung verwendet wird, und daß die Einrichtung zur Demodulation so ausgebildet ist, daß die oberen und die unteren Bereiche demoduliert werden, indem das erste bzw. das Zweite Demodulationssignal verwendet wird.

8. Empfänger nach Anspruch 3, dadurch gekennzeichnet,

daß die Generierungseinrichtungen so ausgebildet sind, daß zusätzlich zu dem Demodulationssignal, welches ein erstes Demodulationssignal ist, ein zweites Demodulationssignal generiert wird, indem das Korrektursignal verwendet wird, und daß die Einrichtung zur Demodulation so ausgebildet ist, daß die oberen und die unteren Bereiche demoduliert werden, indem das erste bzw. das zweite Demodulationssignal verwendet wird.

9. Empfänger nach Anspruch 1, 3, 7 oder 8 für ein Kommunikationssystem, dadurch gekennzeichnet, daß der Sender eine Einrichtung (15, 88) zum Einsetzen des Trägersignals in das Frequenzloch umfaßt, und der Empfänger eine Einrichtung (36) zum Extrahieren des Trägersignals aus dem Frequenzloch nach Empfang umfaßt.

10. Empfänger nach Anspruch 1 oder 7, dadurch gekennzeichnet, daß die Vergleichseinrichtung eine erste Empfänger-Mischeinrichtung (44) umfaßt, die die Eingangssignale empfängt und ein Frequenzloch-Breitensignal ableitet, dessen Frequenz der Frequenzlochbreite entspricht, und eine Einrichtung (45) zur Ableitung des Ausgangssignals der Vergleichseinrichtung aus dem Frequenzloch-Breitensignal umfaßt.

11. Empfänger nach Anspruch 10 sofern er von den Ansprüchen 7 und 9 abhängt, dadurch gekennzeichnet, daß die Generierungseinrichtungen umfassen: eine zweite Empfänger-Mischeinrichtung (40) zum Empfangen und Mischen des Trägersignals und des Ausgangssignals der Vergleichseinrichtung und zum Generieren des ersten und des zweiten Demodulationssignals als obere und untere Seitenbänder, die sich aus dem Mischen ergeben, und daß der Empfänger weiterhin eine dritte und eine vierte Mischeinrichtung (32,33) umfaßt, die das erste und das zweite Demodulationssignal empfangen und die oberen bzw. die unteren Bereiche demodulieren.

12. Empfänger nach Anspruch 1, 8 oder 9, dadurch gekennzeichnet, daß die Korrekturereinrichtung (50,51) demodulierte Ausgangssignale der Demodulationseinrichtung als Eingangssignale empfängt.

13. Empfänger nach Anspruch 12, sofern er von den Ansprüchen 8 und 9 abhängt, dadurch gekennzeichnet, daß die Korrekturereinrichtung eine erste

Empfänger-Mischeinrichtung (50) zum Ableiten des Korrektursignals umfaßt, und daß die Generierungseinrichtungen einen lokalen Generator (52) zur Erzeugung eines Referenzsignales mit einer durch das Korrektursignal gesteuerten Frequenz umfaßt und eine zweite Empfänger-Mischeinrichtung (53) umfaßt, die das Trägersignal und das Referenzsignal empfangen und das erste und das zweite Demodulationssignal erzeugen.

14. Empfänger nach Anspruch 13, dadurch gekennzeichnet, daß die Demodulationseinrichtung eine dritte und eine vierte Empfänger-Mischeinrichtung (32,33) umfaßt, und daß die erste Empfänger-Mischeinrichtung (50) die Ausgangssignale der dritten und der vierten Empfänger-Mischeinrichtung als Eingangssignale empfängt.

15. Empfänger nach einem der Ansprüche 1 oder 8 bis 14, dadurch gekennzeichnet, daß zumindest einige der Einrichtungen von einem programmierten Computer (64) gebildet werden.

16. Kommunikationssysteme nach Anspruch 2, 4, 5 oder 6, dadurch gekennzeichnet, daß zumindest einige der Einrichtungen des Senders und/oder des Empfängers durch einen programmierten Computer (64) gebildet sind.

17. Empfangsverfahren zur Verarbeitung von in einem Kommunikationssystem empfangenen Signalen, das Sende- und Empfangsverfahren einsetzt, wobei das Sendeverfahren umfaßt: Modulieren eines Trägersignals mit einem Informationssignal, Teilen des das modulierte Signal enthaltende Frequenzspektrums in untere und obere Bereiche mit einem dazwischenliegenden Frequenzloch, und Senden der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals, und wobei das Empfangsverfahren umfaßt: Vergleichen der Frequenz und der Phase der Signale aus den unteren und den oberen Bereichen bei Empfang und vor der Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals, um ein Vergleichs-Ausgangssignal bereitzustellen, dadurch gekennzeichnet, daß das Empfangsverfahren desweiteren umfaßt: Erzeugen von ersten und von zweiten Demo-

dulationssignalen unter Verwendung des Vergleichs-Ausgangssignals und des frequenzumgesetzten Trägersignals, und Demodulieren der oberen und der unteren Bereiche durch Einsatz der ersten bzw. der zweiten Demodulationssignale, um denselben Frequenzabschnitt zu besetzen, wie die Signale in jenen Bereichen, die in dem Informationssignal vor der Modulation und der Teilung besetzt waren.

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18. Empfangsverfahren zur Verarbeitung von in einem Kommunikationssystem empfangenen Signalen, das Sende- und Empfangsverfahren einsetzt, wobei das Sendeverfahren umfaßt: Modulieren eines Trägersignals mit einem Informationssignal,

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Teilen des das modulierte Signal enthaltende Frequenzspektrums in untere und obere Bereiche mit einem dazwischenliegenden Frequenzloch, und

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Senden der oberen und der unteren Bereiche und des frequenzumgesetzten Trägersignals, und

wobei das Empfangsverfahren umfaßt:

Ableiten des Korrektursignals durch Vergleich der Frequenz und der Phase der Signale aus den unteren und den oberen Bereichen bei Empfang, gefolgt von einer Frequenzumsetzung in das ursprüngliche Spektrum des Informationssignals, Erzeugen von ersten und von zweiten Demodulationssignalen unter Verwendung des Vergleichs-Ausgangssignals und des frequenzumgesetzten Trägersignals, und Demodulieren der oberen und der unteren Bereiche durch Einsatz der ersten bzw. der zweiten Demodulationssignale, um denselben Frequenzabschnitt zu besetzen, wie die Signale in jenen Bereichen, die in dem Informationssignal vor der Modulation und der Teilung besetzt waren.

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Revendications

1. Récepteur pour un système de communication, qui emploie un émetteur et le récepteur, l'émetteur comprenant :

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des moyens de modulation (10,11,75,76) pour moduler un signal porteur avec un signal d'information,

des moyens de sélection et de décalage de fréquences (12 à 17,23,24,77,78,79,86) pour diviser une bande de fréquence contenant le signal modulé en une portion supérieure et une portion inférieure et pour effectuer un décalage de fréquences, le signal de sortie des

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moyens de sélection et de décalage de fréquence ayant au moins une portion qui est décalée en fréquence pour procurer une enco-

che entre la portion supérieure et la portion inférieure, et

des moyens (15,18,88) pour transmettre la portion supérieure et la portion inférieure et ledit signal porteur, ce signal porteur étant décalé en fréquence,

le récepteur comprenant :

des moyens de comparaison (44,45) pour comparer la fréquence et la phase de signaux en provenance des portions inférieure et supérieure, lors de la réception, avant un décalage de fréquence pour revenir au spectre d'origine du signal d'information,

caractérisé en ce que le récepteur comprend également :

des moyens générateurs(40,42,43) pour engendrer un signal de démodulation, les moyens générateurs étant couplés pour recevoir le signal de sortie des moyens de comparaison et le signal porteur décalé en fréquence et pour les utiliser pour engendrer le signal de démodulation, et

des moyens (32,33) pour démoduler au moins l'une des portions supérieure et inférieure en utilisant le signal de démodulation pour occuper la même plage de fréquences que des signaux dans cette(ces) portion(s) occupée(s) dans ledit signal d'information avant modulation et division.

2. Système de communication comprenant un émetteur et un récepteur,

l'émetteur comprenant des moyens de modulation (10,11,75,76) pour moduler un signal porteur avec un signal d'information,

des moyens de sélection et de filtrage de fréquences (12 à 17,23,24,77,78,79,86) pour diviser le spectre de fréquences contenant le signal porteur modulé en une portion supérieure et une portion inférieure et pour effectuer un décalage de fréquences, le signal de sortie des moyens de sélection et de décalage de fréquences ayant au moins une portion qui est décalée en fréquence pour procurer une encoche entre les portions inférieure et supérieure, et

des moyens (15,18,88) pour transmettre les portions supérieure et inférieure et le signal porteur, ce signal porteur étant décalé en fréquence,

le récepteur comprenant :

des moyens (44,45) pour comparer la fréquence et la phase de signaux en provenance des portions inférieure et supérieure, lors de la réception, avant un décalage de fréquences pour revenir au spectre d'origine du signal d'information,

caractérisé en ce que le récepteur comprend :

- des moyens générateurs (40,42,43) pour engendrer un signal de démodulation, les moyens générateurs étant couplés pour recevoir le signal de sortie des moyens de comparaison et le signal porteur décalé en fréquence et pour les utiliser pour engendrer le signal de démodulation, et
des moyens (32,33) pour démoduler au moins l'une des portions supérieure et inférieure en utilisant le signal de démodulation pour occuper la même plage de fréquences que des signaux dans cette(s) portion(s) occupée(s) dans ledit signal d'information avant modulation et division.
3. Récepteur pour un système de communication qui emploie un émetteur et un récepteur, l'émetteur comprenant :
des moyens de modulation (10,11,75,76) pour moduler un signal porteur avec un signal d'information,
des moyens de sélection et de décalage de fréquences (12 à 17,23,24,77,78,79,86) pour diviser une bande de fréquences contenant le signal modulé en une portion supérieure et une portion inférieure et pour effectuer un décalage de fréquences, le signal de sortie des moyens de sélection et de décalage de fréquences ayant au moins une portion qui est décalée en fréquence pour procurer une encoche entre la portion inférieure et la portion supérieure, et
des moyens (15,18,88) pour transmettre les portions supérieure et inférieure et le signal porteur, ce signal porteur étant décalé en fréquence,
le récepteur comprenant :
des moyens de correction (50,51) pour comparer la fréquence et la phase de signaux en provenance des portions inférieure et supérieure, lors de la réception, après un décalage de fréquences pour revenir au spectre d'origine du signal d'information, caractérisé en ce que le récepteur comprend :
des moyens générateurs (52 à 55) pour engendrer un signal de démodulation, les moyens générateurs étant couplés pour recevoir le signal de sortie en provenance des moyens de correction et le signal porteur décalé en fréquence et pour les utiliser pour engendrer le signal de démodulation, et
des moyens (32,33) pour démoduler les portions supérieure et inférieure en utilisant le signal de démodulation pour occuper la même plage de fréquences que des signaux dans ces portions occupées dans le signal d'information avant modulation et division.
4. Système de communication comprenant un émetteur et un récepteur, l'émetteur comprenant des moyens de modulation (10,11,75,76) pour moduler un signal porteur avec un signal d'information, des moyens de sélection et de filtrage de fréquences (12 à 17,23,24,77,78,79,86) pour diviser le spectre de fréquences contenant le signal porteur modulé en une portion supérieure et une portion inférieure et pour effectuer un décalage de fréquences, le signal de sortie des moyens de sélection et de décalage de fréquences ayant au moins une portion qui est décalée en fréquence pour procurer une encoche entre la portion inférieure et la portion supérieure, et
des moyens (15,18,88) pour transmettre les portions supérieure et inférieure et le signal porteur, ce signal porteur étant décalé en fréquence,
le récepteur comprenant :
des moyens de correction (50,51) pour comparer la fréquence et la phase de signaux en provenance des portions inférieure et supérieure, lors de la réception, après un décalage de fréquences pour revenir au spectre d'origine du signal d'information, caractérisé en ce que le récepteur comprend :
des moyens générateurs (52 à 55) pour engendrer un signal de démodulation, les moyens générateurs étant couplés pour recevoir le signal de sortie en provenance des moyens de correction et le signal porteur décalé en fréquence et pour les utiliser pour engendrer le signal de démodulation, et
des moyens (32,33) pour démoduler les portions supérieure et inférieure en utilisant le signal de démodulation pour occuper la même plage de fréquences que des signaux dans ces portions occupées dans le signal d'information avant modulation et division.
5. Système de communication selon la revendication 2 ou la revendication 4, caractérisé en ce que les moyens de modulation de l'émetteur comprennent des moyens (10,11,76) pour mélanger le signal d'information et le signal porteur.
6. Système de communication selon la revendication 2 ou la revendication 4, caractérisé en ce que les moyens de modulation de l'émetteur comprennent un modem employant l'une des techniques suivantes : codage à saut de phase binaire et codage à saut de phase en quadrature.

7. Récepteur selon la revendication 1, caractérisé en ce que, en plus dudit signal de démodulation, qui est un premier signal de démodulation, les moyens générateurs sont agencés pour engendrer un deuxième signal de démodulation utilisant le signal de sortie des moyens de comparaison, et en ce que les moyens de démodulation sont agencés pour démoduler les portions supérieure et inférieure en utilisant respectivement le premier signal de démodulation et le deuxième signal de démodulation.
8. Récepteur selon la revendication 3, caractérisé en ce que, en plus dudit signal de démodulation, qui est un premier signal de démodulation, les moyens générateurs sont agencés pour engendrer un deuxième signal de démodulation utilisant le signal de correction, et en ce que les moyens de démodulation sont agencés pour démoduler les portions supérieure et inférieure en utilisant respectivement le premier signal de démodulation et le deuxième signal de démodulation.
9. Récepteur selon l'une des revendications 1, 3, 7 ou 8, pour un système de communication, caractérisé en ce que l'émetteur comporte des moyens (15,88) pour insérer le signal porteur dans l'encoche, le récepteur comportant des moyens (36) pour extraire à la réception le signal porteur de l'encoche.
10. Récepteur selon la revendication 1 ou la revendication 7, caractérisé en ce que les moyens de comparaison comprennent des premiers moyens mélangeurs de réception (44) agencés pour recevoir les signaux d'entrée et pour dériver un signal de largeur d'encoche ayant une fréquence égale à la largeur de l'encoche, et des moyens (45) pour dériver le signal de sortie des moyens de comparaison du signal de largeur d'encoche.
11. Récepteur selon la revendication 10, pour autant qu'elle dépend des revendications 7 et 9, caractérisé en ce que les moyens générateurs comprennent des deuxième moyens mélangeurs de réception (40) agencés pour recevoir et mélanger le signal porteur et le signal de sortie des moyens de comparaison et pour engendrer les premier et deuxième signaux de démodulation en tant que bandes latérales supérieure et inférieure résultant dudit mélange, et en ce que le récepteur comporte également des troisième et des quatrième moyens mélangeurs (32,33) agencés pour recevoir les premier et deuxième signaux de démodulation et pour démoduler respectivement la portion supérieure et la portion inférieure.
12. Récepteur selon l'une des revendications 1, 8 ou 9, caractérisé en ce que les moyens de correction (50,51) sont agencés pour recevoir, en tant que signaux d'entrée, les signaux de sortie démodulés en provenance des moyens de démodulation.
13. Récepteur selon la revendication 12, pour autant qu'elle dépend des revendications 8 et 9, caractérisé en ce que les moyens de correction comprennent des premiers moyens mélangeurs de réception (50) pour dériver le signal de correction, et en ce que les moyens générateurs comprennent un générateur local (52) pour engendrer un signal de référence ayant une fréquence contrôlée par le signal de correction, et des deuxième moyens mélangeurs de réception (53) agencés pour recevoir le signal porteur et le signal de référence et pour engendrer les premier et deuxième signaux de démodulation.
14. Récepteur selon la revendication 13, caractérisé en ce que les moyens de démodulation comprennent des troisième et quatrième moyens mélangeurs de réception (32,33) et en ce que les premiers moyens mélangeurs de réception (50) sont agencés pour recevoir, en tant que signaux d'entrée, les signaux de sortie des troisième et quatrième moyens mélangeurs de réception.
15. Récepteur selon l'une des revendications 1 ou 8 à 14, caractérisé en ce qu'au moins certains desdits moyens sont formés par un ordinateur programmé (64).
16. Système de communication selon l'une des revendications 2, 4, 5 ou 6, caractérisé en ce qu'au moins certains desdits moyens de l'émetteur et/ou du récepteur sont formés par un ordinateur programmé (64).
17. Méthode de réception pour traiter des signaux reçus dans un système de communication qui emploie des méthodes d'émission et de réception, la méthode d'émission consistant à moduler un signal porteur avec un signal d'information, à diviser le spectre de fréquences contenant le signal modulé en une portion inférieure et une portion supérieure, avec une encoche de fréquences entre la portion inférieure et la portion supérieure, et à transmettre les portions supérieure et inférieure et le signal porteur, ce dernier étant décalé en fréquence,

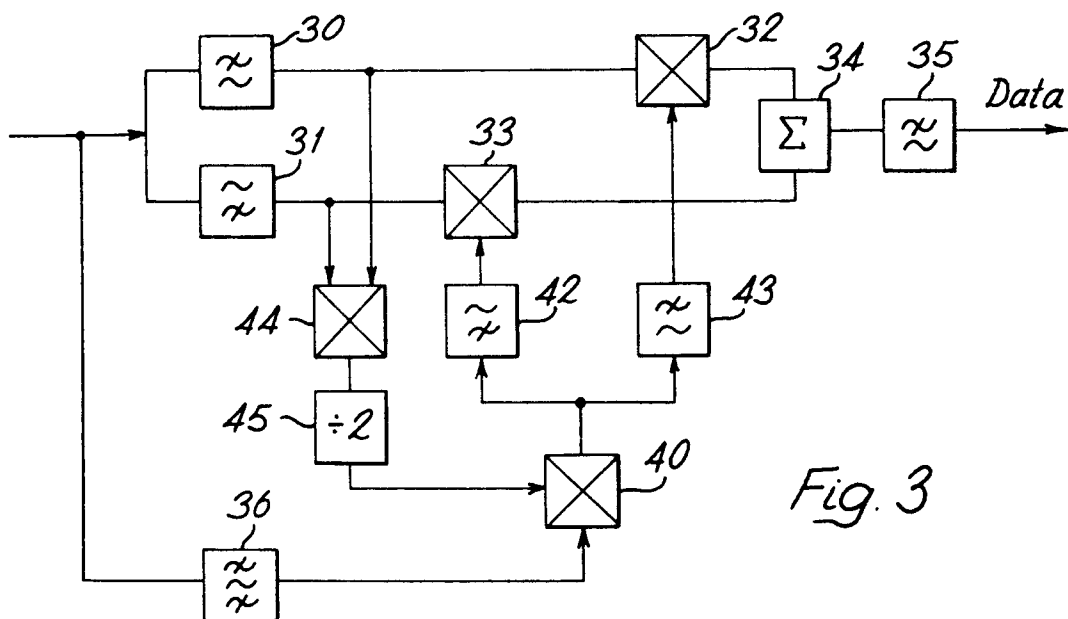
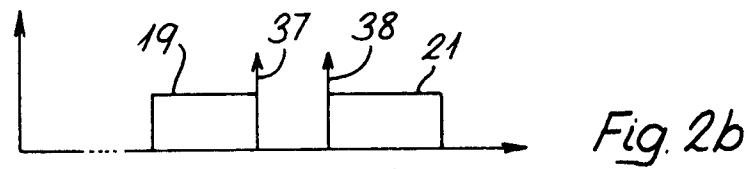
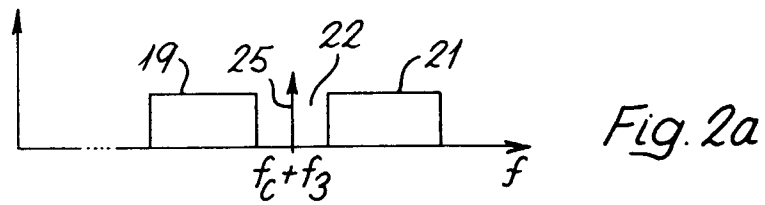
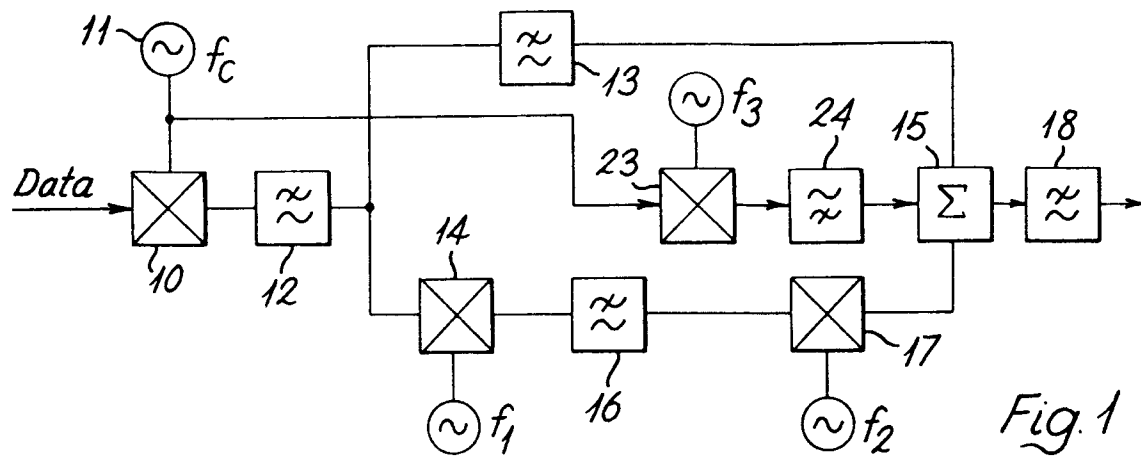
et

la méthode de réception consistant à comparer la fréquence et la phase de signaux en provenance des portions inférieure et supérieure, lors de la réception, avec un décalage de fréquences pour revenir au spectre d'origine du signal d'information, afin de procurer un signal de sortie de comparaison, caractérisé en ce que la méthode de réception consiste également à :

engendrer un premier signal de démodulation et un deuxième signal de démodulation et à employer le signal de sortie de comparaison et le signal porteur décalé en fréquence pour engendrer les premier et deuxième signaux de démodulation, et

démoduler les portions supérieure et inférieure en utilisant respectivement les premier et deuxième signaux de démodulation pour occuper la même plage de fréquences que des signaux dans ces portions occupées dans ledit signal d'information avant modulation et division.

- 18.** Méthode de réception pour traiter des signaux reçus dans un système de communication qui emploie des méthodes d'émission et de réception, la méthode d'émission consistant à moduler un signal porteur avec un signal d'information, à diviser le spectre de fréquences contenant le signal modulé en une portion inférieure et une portion supérieure avec une encoche de fréquences entre la portion inférieure et la portion supérieure, et à transmettre les portions supérieure et inférieure et le signal porteur, ce dernier étant décalé en fréquence, et
- la méthode de réception consistant à :
- dérivée un signal correcteur en comparant la fréquence et la phase des signaux en provenance des portions inférieure et supérieure, lors de la réception, après un décalage de fréquences pour revenir au spectre d'origine du signal d'information,
- engendrer un premier et un deuxième signal de démodulation et à employer le signal de correction et le signal porteur décalé en fréquence pour engendrer les premier et deuxième signaux de démodulation, et
- démoduler la portion supérieure et la portion inférieure en utilisant respectivement le premier et le deuxième signal de démodulation pour occuper la même plage de fréquences que des signaux dans ces portions occupées dans ledit signal d'information avant modulation et division.



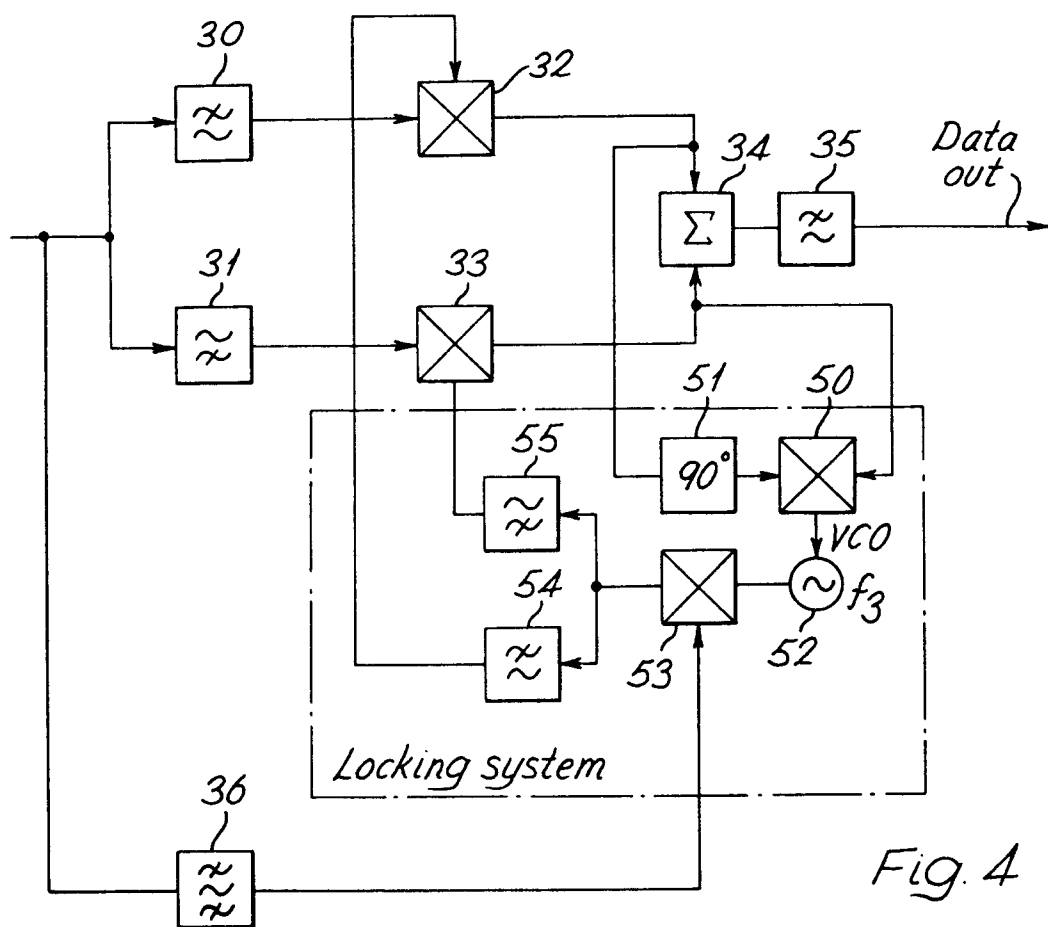


Fig. 4

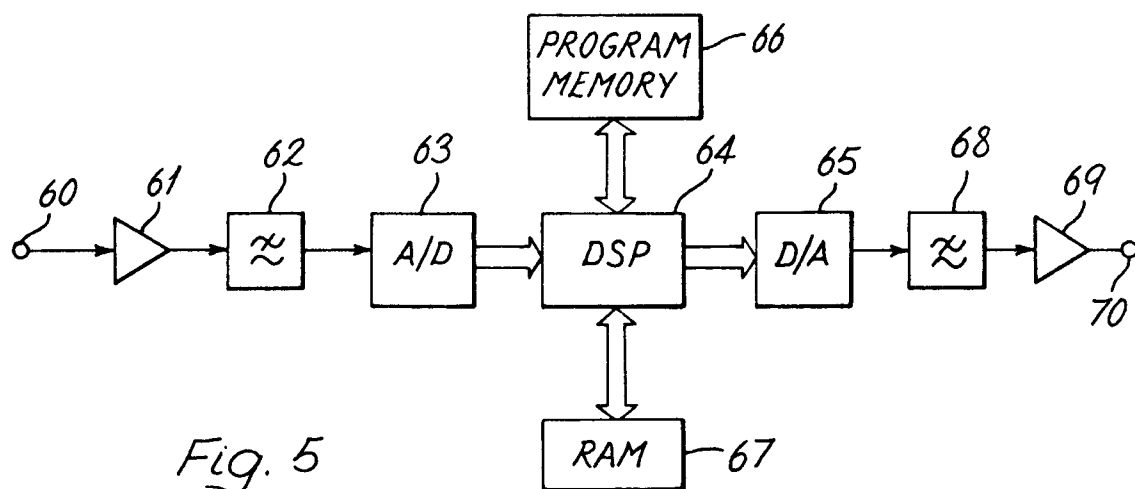


Fig. 5

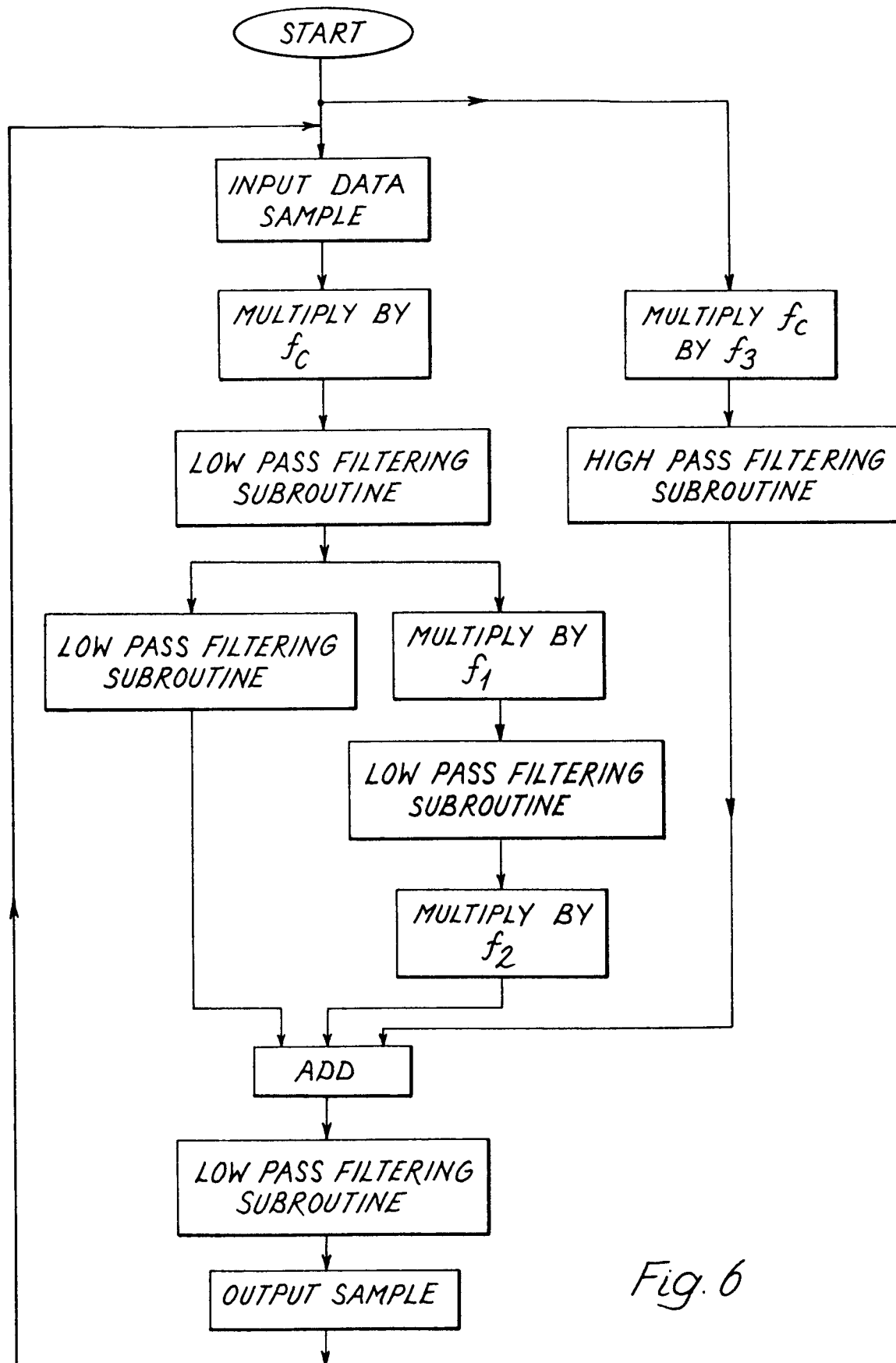


Fig. 6

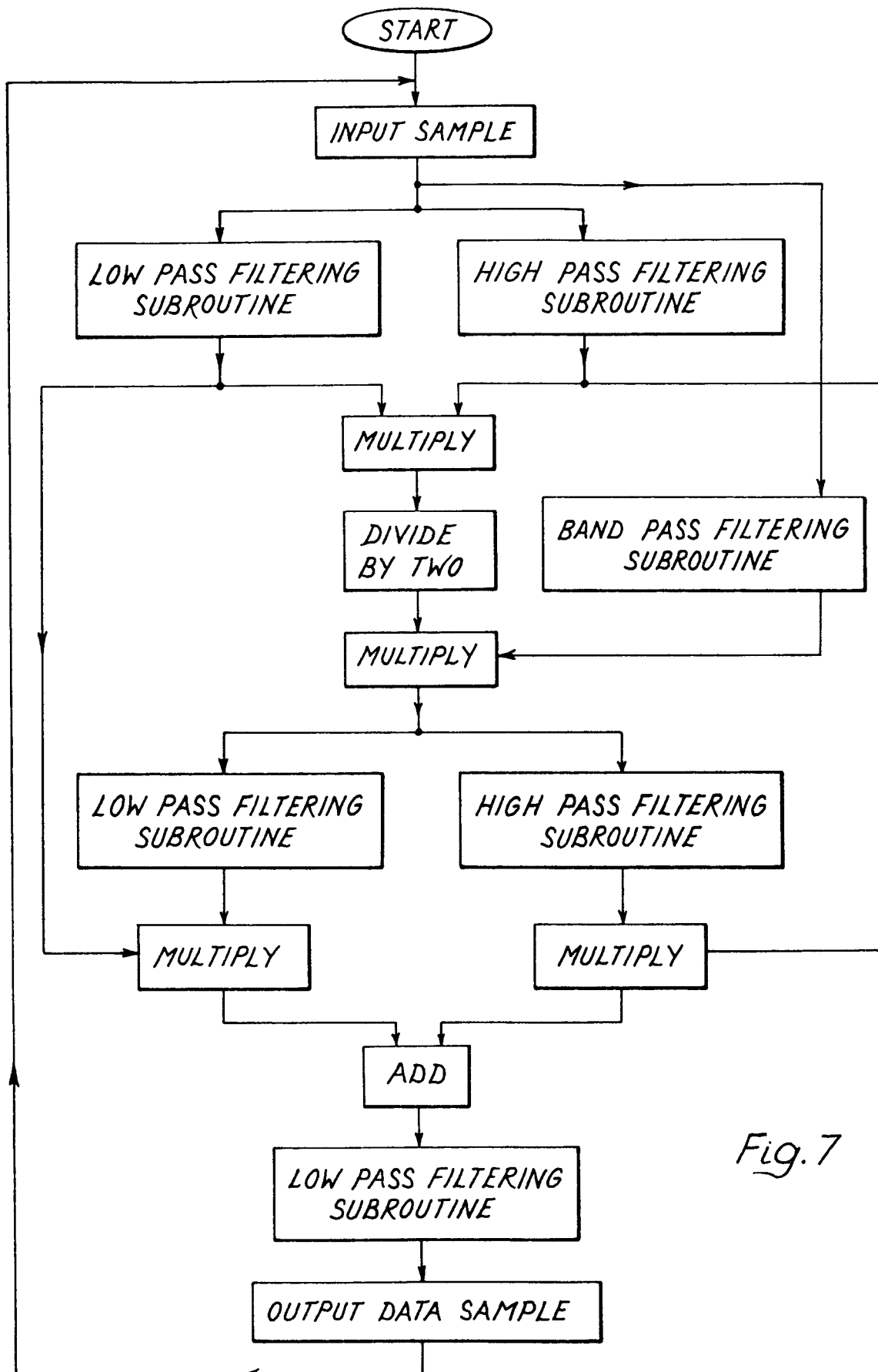


Fig. 7

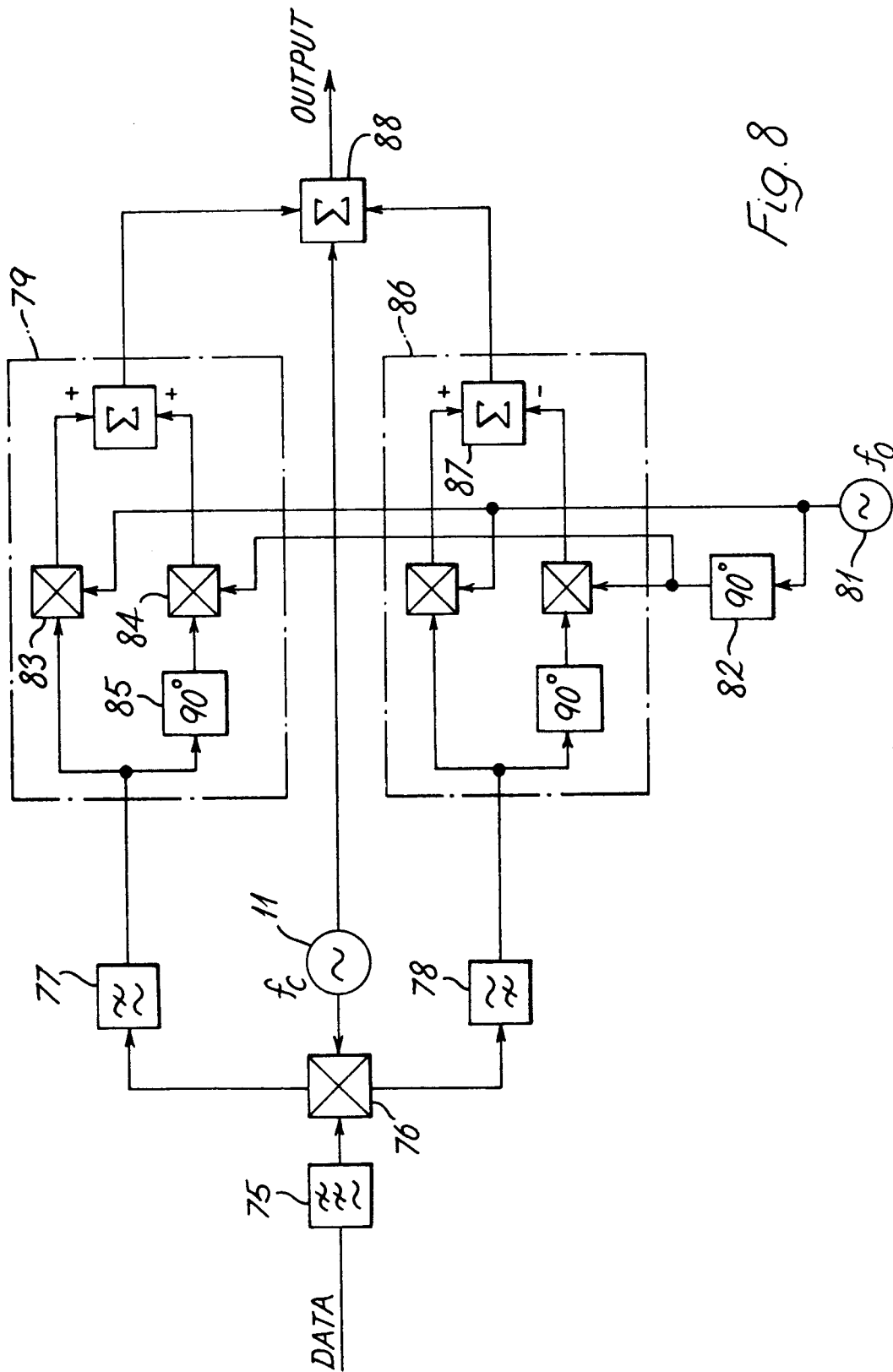


Fig. 8